Field Report for Airborne Data Collected In Support of US EPA Region VI Intercontinental Terminals Company LLC Fire 20 March 2019

Background

On 17 March 2019 a large fire was reported at the Intercontinental Terminals Company LLC (ITC) located in Deer Park, TX. Local reports indicate that the fire started at about 1030 local in an 80,000 barrel (capacity) tank storing naphtha. The ITC facility is located on the southern shore of the Houston ship channel in the City of Deer Park, TX. The geographical coordinates of the facility are 19.7322N, 95.1236W (figure 1).

The material reported in the fire is Naphtha. Naphtha is generally composed of either the first or second sequence of distillate obtained during primary distillation. Light naphtha is composed of light fraction straight chain and simple aromatics, typically less than 6 carbons while heavy naphtha consist of larger compounds (C6 plus) which normally is used as feed for catalytic cracking. Since the fraction of Naphtha is crude dependent, there is not a simple formula for the material.

The US EPA Region VI requested that the ASPECT system be deployed to provide monitoring support on 17 March 2019 and ASPECT completed a 7 pass mission at 1847 local. Acetone was detected on the first 2 passes (data collection 3 and 4) which were near the fire at a concentration estimated below 1 ppm (0.154 ppm and 0.357 ppm, respectively). No other compounds were detected.

ASPECT conducted a second flight over the facility on 18 March 2019. Analysis of IR data confirmed reports that the fire had expanded to multiple tanks. Specifically, the thermal signature of the fire and resulting heated air plume was measurably larger than that observed in the first flight. Crew reports indicated that the plume rise was still active with the lofted plume occupying a region between 2000 and 6500 feet above ground with movement to the west. Spectral analysis of FTIR data indicated that compounds including 1-butene, 2-butene, isoprene, and acetone were detected primarily in a downwind portion of the plume with the highest values being just above 1 ppm.

ASPECT conducted a third flight over the ITC fire on 19 March 2019. Analysis of data indicated that the fire had grown as evident by the larger thermal signature and direct confirmation from aerial images. Plume geometry was assessed with the aircraft with findings showing the plume was about 47 miles in length, 17 miles wide at the largest extent and ranged in altitude from a floor of 1500 feet to a ceiling of 5000 feet. No chemical detections were reported on this flight. ASPECT was requested to fly follow up mission on 20 March 2019 which is detailed in the following report.

Figure 1: ITC, Deer Park, TX

ASPECT response to this Mission/Incident was in support of:
US EPA Region 6. OSC: Adam Adams

ASPECT System

The US EPA ASPECT system collects airborne infrared (IR) images and chemical screening data from a safe distance over the site (about 3,000 ft AGL). The system consists of an airborne high speed Fourier transform infrared spectrometer (FTIR) coupled with a wide-area IR line scanner (IRLS). The ASPECT IR systems have the ability to detect compounds in both the 8 to 12 micron (800 to 1200 cm-1) and 3 to 5 micron (2000 to 3200 cm-1) regions. The 8 to 12 micron region is typically known as the atmospheric window region since the band is reasonably void of water and carbon dioxide influence. Spectrally, this region is used to detect carbon - non-carbon bonded compounds. The 3 to 5 micron region is also free of water and carbon dioxide but typically does not have sufficient energy for use. This band does show use in high-energy environments such as fires. The carbon - hydrogen stretch is very common in this region.

A digital Nikon DX2 camera (12.4 mega pixel CMOS 3:5 aspect ratio, 28 mm wide-angle lens) collects visible aerial imagery as part of the core data product package. The camera timing system is connected to the primary IR sensors and provides concurrent image collection when other sensors are triggered. All imagery is geo-rectified using both aircraft attitude correction (pitch, yaw, and roll) and GPS positional information. Imagery can be processed while in flight or approximately 600 frames per hour can be processed once the data are downloaded from the aircraft.

An Imperx mapping camera (29 mega pixels; mapping focal plane array) provides a similar aspect ratio and aerial coverage. Like the Nikon DX2, it is connected to the primary IR sensors and provides concurrent image collection when other sensors are triggered. These images are often digitally processed in lower resolution so they can be transmitted via satellite communication. The high resolution images (>20 MB each) are pulled from the ASPECT after the sortie and are available at a later time.

All aerial photographic images collected by the ASPECT system are ortho-rectified and geospatially validated by the reachback team. In general, this consists of conducting geo-registration using a Digital Elevation Model (DEM) which promotes superior pixel computation and lessens topographic distortion. The image is then check by a team member (using a Google Earth base map) for proper location and rotation

Data is processed using automated algorithms onboard the aircraft with preliminary results being sent using a satellite system to the ASPECT reachback team for QA/QC analysis. Upon landing preliminary data results are examined and validated by the reachback team.

Data Results Flight 4, 20 March 2019

Weather Conditions and Crew Report

Weather for the mission is given in table 1. The crew reported that winds at altitude (2800 ft) are at about 10 kts (5 m/s) from about 070 degrees. On the first pass no evidence of smoke was noted from the tank farm but due to morning haze, a light emission may be masked. On subsequent passes, the crew reported very light emissions being generated by the tank farm.

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Table 1. ITC Fire Mission Weather 20 March 2019

Parameter	Surface (0930)	Surface (1200)
Wind direction	000 degrees	030 degrees
Wind speed	Calm	1 m/s
Temperature	16ºC	23 ºC
Humidity	68%	38%
Dew Point	10.5ºC	6 ºC
Pressure	1026 mb	1026 mb
Ceiling	Not Reported	Not Reported

The order to launch the aircraft was given at 0900 local on 20 March 2019 and the aircraft was airborne at 0930. The initial data collection run over the site was at 0955 (local) and the aircraft made a total of 8 data collection passes; flight information is summarized in Appendix A and Figure 2.

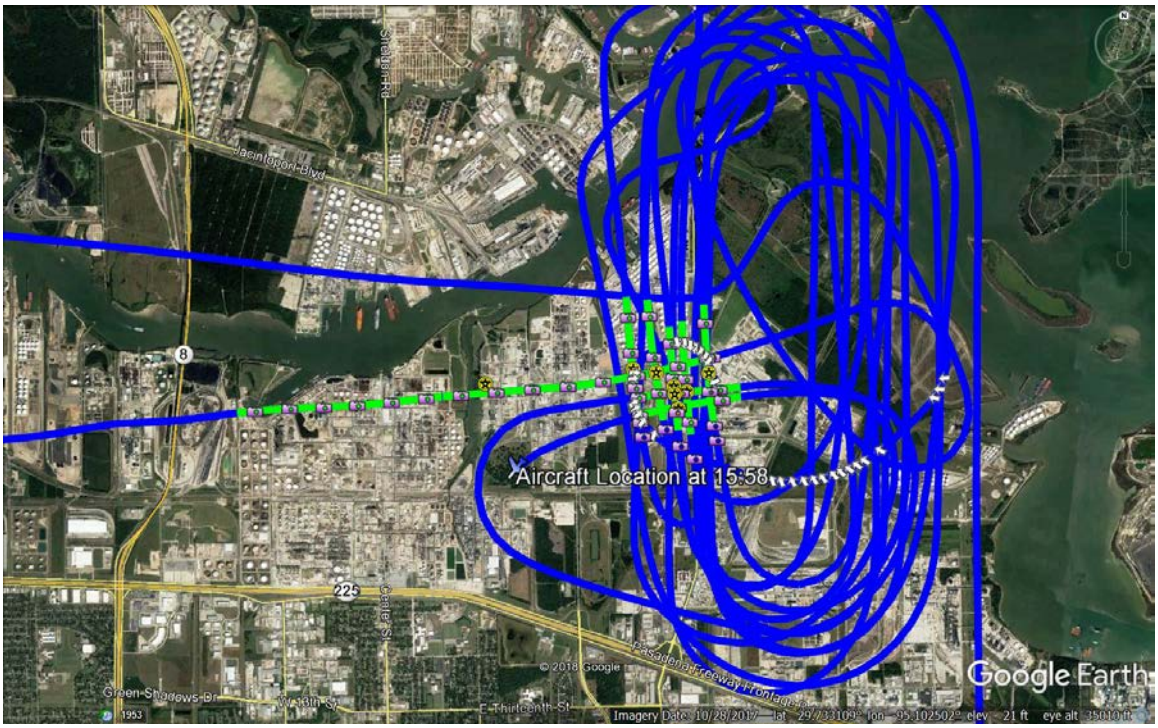

Figure 2: Flight line data for 20 March 2019. The blue lines represent the ASPECT flight path, green lines represent when the Infrared Line Scanner was actively collecting data, and the camera icons represent when a photo was taken.

General Data Quality Objective

The following general data quality objectives are employed in conducting emergency response data collection with ASPECT:

1. To support overall situational analysis of the incident including aerial photography and IR imagery
2. To screen the incident for the presence of selected chemicals
3. To estimate the location and concentration of plumes being generated by the incident.

Line Scanner Data Results

A total of 1 test and 8 data passes were made in the proximity of the site and an infrared line scanner images were generated for each pass. Figure 3 shows a typical 3-band infrared image obtained from data collected for Run 5. Examination of the IR image clearly shows that the fire is out due to the absence of any image saturation. Tanks on the NE corner of the farm and the center east tank do show some elevated temperature. A thermal analysis developed from the same pass of data does show that these tanks are elevated in temperature, showing an approximate temperature of about 60^{o}C as depicted by the yellow color (figure 4). It should be stressed that while these vessels are higher than the surrounding, there are other process related structures in the scene that are hotter which are shown as red. No plumes were detected in the image.

Figure 3: IR image ITC, 20 March 2019, Run 5

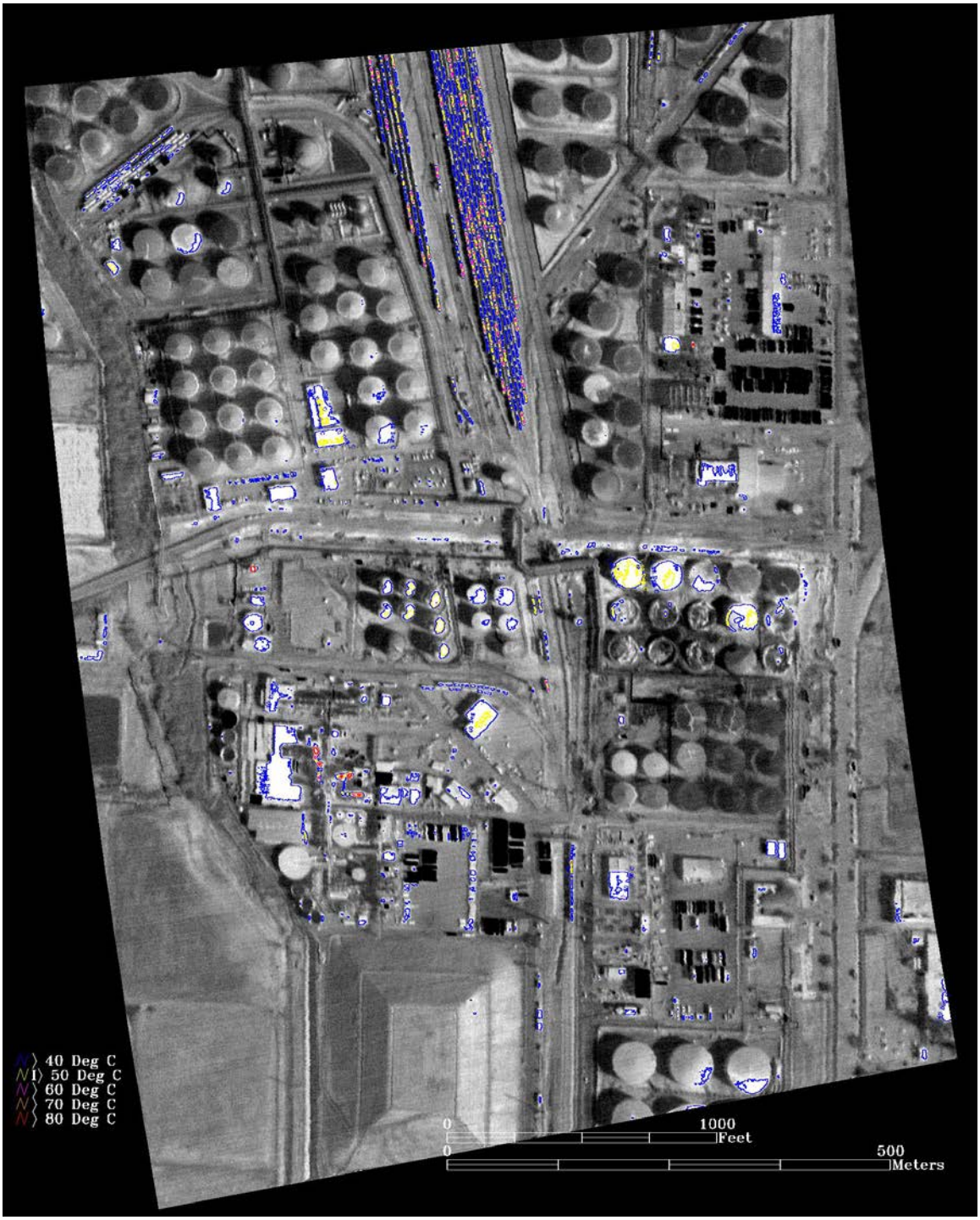

Figure 4: Thermal analysis of ITC data for 20 March 2019, Run 5

FTIR Data Results

FTIR Spectral data at a resolution of 16 wavenumbers was collected for each pass. ASPECT uses an automated detection algorithm to permit compounds to be analyzed while the aircraft is in flight. 72 compounds are included in this algorithm and the list and associated detection limits are given in Table 2. In addition, collected data

are also manually analyzed by comparing any detected spectral signatures to a collection of published library spectra.

An examination of FTIR data collected on this mission showed low level detection west and south of the tank farm (Figure 5). Detections west of the farm include acetone (0.283ppm) and SO_2 (0.653 ppm). Based on the wind direction these detections are likely being transported into the area and are not associated with the former fire. Detections observed south of the tank farm include isobutylene (0.284 ppm) and isoprene (0.098 ppm) and may be associated with normal compounds in the urban air.

Figure 5: ITC Fire, Chemical Detection Locations – 20 March 2019

A summary of chemical detections is given in table 3.

Table 3. Chemical Results Summary

Run	Date	Time (UTC)	Chemical	Max Concentration ppm
1	20 March 2019	0946	Test	Test
2		0955	Test	Test
3		1003	ND	None
4		1006	ND	None
5		1010	ND	None
6		1020	ND	None
7		1054	Acetone SO_2	0.283 0.652
8		1058	Isobutylene Isoprene	0.284 0.098

ND – Non-detect

Aerial Photography Results

A full set of high resolution aerial digital photography were collected as part of the flight. Figure 6 shows a representative overhead image collected as part of each pass. As evident in the image, the fires associated with the tank farm are absent. In addition, the secondary containment area of the tank farm appears to be filled with a white substance. Figure 7 illustrates a typical oblique image. Both images confirm the finding that the fire has been extinguished and that the secondary containment is filled with a white substance.

Figure 6: Aerial Image of the ITC Fire, Flight 4

Figure 7: Oblique Image of the ITC Fire, Flight 4

Conclusions

ASPECT conducted a fourth flight over the ITC fire on 20 March 2019. Analysis of data indicated that the fire had been extinguished. Analysis of FTIR data showed detections of acetone and SO_2 to west of the farm and isobutylene and isoprene south of the farm. All concentrations were detected below 1 ppm

Appendix A

Abbreviations:

DEM – Digital elevation model
Alt – Altitude (in feet)
MSL – Mean sea level altitude (in feet)
Digital – Digital photography file from the Nikon D2X camera
MSIC – Digital photography file from the Imperx mapping camera
FTIR – Spectral IR data collected with a Fourier Transform Infrared Spectrometer
IRLS – Infrared Line Scanner
Jpg – JPEG image format
UTC – Universal Time Coordinated
img – Spectral data format based on Grams format

Mission: 2019-03-20 ITC Fire

Date: 3/20/2019

Time UTC: 14:35

Aircraft Number: N9738B

Pilot: Beorn Ledger

Copilot: Beorn Ledger

Operator: Bob Kirby

Aft Operator: Bob Kirby

Ground Controller: Tim Curry

DEM: Using elevation from DEM Database

Run: 1 Time: 14:46:43 UTC

Alt: 2961 ft MSL Elev: 4 ft Elevation from DEM Database

Vel: 134 knots Heading: 0

Digitals: None

MSIC: 3

20190320144648713.jpg

20190320144655077.jpg

20190320144702331.jpg

FTIR: 1

20190320_144646_A.igm

IRLS: 1

2019_03_20_14_46_46_R_01 TA=8.0;TB=28.0;Gain=3

Gamma Runs: None

Run: 2 Time: 14:55:40 UTC

Alt: 2803 ft MSL Elev: 18 ft Elevation from DEM Database

Vel: 121 knots Heading: 170

Digitals: None

MSIC: 4

20190320145546165.jpg

20190320145552514.jpg

20190320145559783.jpg

20190320145606132.jpg

FTIR: 1

20190320_145544_A.igm

IRLS: 1

2019_03_20_14_55_44_R_02 TA=7.9;TB=27.9;Gain=3

Gamma Runs: None

Run: 3 Time: 14:59:50 UTC

Alt: 2725 ft MSL Elev: 18 ft Elevation from DEM Database

Vel: 111 knots Heading: 171

Digitals: None

MSIC: 4

20190320145955832.jpg

20190320150002181.jpg

20190320150008546.jpg

20190320150014895.jpg

FTIR: 1

20190320_145952_A.igm

IRLS: 1

2019_03_20_14_59_53_R_03 TA=10.1;TB=30.1;Gain=3

Gamma Runs: None

Run: 4 Time: 15:03:22 UTC

Alt: 2775 ft MSL Elev: 19 ft Elevation from DEM Database

Vel: 112 knots Heading: 172

Digitals: None

MSIC: 5

20190320150329184.jpg

20190320150335533.jpg

20190320150341882.jpg

20190320150348246.jpg

20190320150350961.jpg

FTIR: 1

20190320_150327_A.igm

IRLS: 1

2019_03_20_15_03_27_R_04 TA=10.7;TB=30.7;Gain=3

Gamma Runs: None

Run: 5 Time: 15:06:54 UTC

Alt: 2735 ft MSL Elev: 17 ft Elevation from DEM Database

Vel: 117 knots Heading: 167

Digitals: None

MSIC: 4

20190320150659806.jpg

20190320150707091.jpg

20190320150713424.jpg

20190320150719773.jpg

FTIR: 1

20190320_150657_A.igm

IRLS: 1

2019_03_20_15_06_58_R_05 TA=10.7;TB=30.7;Gain=3

Gamma Runs: None

Run: 6 Time: 15:10:49 UTC

Alt: 2752 ft MSL Elev: 19 ft Elevation from DEM Database

Vel: 114 knots Heading: 169

Digitals: None

MSIC: 5

20190320151055854.jpg

20190320151102203.jpg

20190320151108552.jpg

20190320151114917.jpg

20190320151117631.jpg

FTIR: 1

20190320_151052_A.igm

IRLS: 1

2019_03_20_15_10_54_R_06 TA=11.5;TB=31.5;Gain=3

Gamma Runs: None

Run: 7 Time: 15:20:31 UTC

Alt: 2748 ft MSL Elev: 15 ft Elevation from DEM Database

Vel: 114 knots Heading: 82

Digitals: None

MSIC: 14

20190320152037794.jpg

20190320152044143.jpg

20190320152050507.jpg

20190320152056856.jpg

20190320152103221.jpg

20190320152109570.jpg

20190320152115919.jpg

20190320152122284.jpg

20190320152128633.jpg

20190320152134997.jpg

20190320152141346.jpg

20190320152147695.jpg

20190320152154964.jpg

20190320152201313.jpg

FTIR: 3

20190320_152035_A.igm

20190320_152113_A.igm

20190320_152151_A.igm

IRLS: 1

2019_03_20_15_20_36_R_07 TA=11.4;TB=31.4;Gain=3

Gamma Runs: None

Run: 8 Time: 15:54:51 UTC

Alt: 2814 ft MSL Elev: 17 ft Elevation from DEM Database

Vel: 123 knots Heading: 262

Digitals: None

MSIC: 3

20190320155456871.jpg

20190320155503220.jpg

20190320155510489.jpg

FTIR: 1

20190320_155453_A.igm

IRLS: 1

2019_03_20_15_54_55_R_08 TA=11.9;TB=31.9;Gain=3

Gamma Runs: None

Run: 9 Time: 15:58:00 UTC

Alt: 2756 ft MSL Elev: 22 ft Elevation from DEM Database

Vel: 127 knots Heading: 257

Digitals: None

MSIC: 3

20190320155806610.jpg

20190320155813879.jpg

20190320155820228.jpg

FTIR: 1

20190320_155804_A.igm

IRLS: 1

2019_03_20_15_58_05_R_09 TA=17.9;TB=38.0;Gain=3

Gamma Runs: None

Mission Complete: 16:40 (UTC)